DOCUMENT RESUME

ED 231 401 IR 050 383

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TITLE Users Look at Online Catalogs. Part 2: Interacting with Online Catalogs. Final Report.
INSTITUTION California Univ., Berkeley. Systemwide Administration. Library Studies and Research Div.
SPONS AGENCY Council on Library Resources, Inc., Washington, D.C.
PUB DATE 29 Apr 83
NOTE 105p.; For related documents, see IR 050 349 and IR 050 382.
PUB TYPE Reports - Research/Technical (143)

EDRS PRICE MF01/PC05 Plus Postage.
DESCRIPTORS Data Collection; Design Requirements; Library Automation; *Library Catalogs; Library Research; *Man Machine Systems; *Online Systems; *Research Methodology; *Search Strategies; Use Studies
IDENTIFIERS Library Users; *Online Catalogs; *Transaction Log Analysis

ABSTRACT

This report focuses on a discussion of findings from analyses of computer transaction logs contributed by four of the online catalog systems used in the Public Access Project. It supplements the analyses of User and Non-User Questionnaires by providing analyses of data from the systems themselves. The four systems contributing data to this analysis were (1) MUMS/SCORPIO, two related systems used at the Library of Congress; (2) LUIS, the Northwestern University public access system; (3) ULISYS (Universal Library Systems), a turnkey vendor system at the West Valley Community College District; and (4) MELVYL, the prototype online union catalog of the University of California. The contents of the four transaction logs are described in detail and samples are provided. For each system the analysis includes the relative use of system commands and access points, tables of transactions, transitions from one command to another, and measures of the complexity of actual searches conducted by users. Use of commands is analyzed both in raw form and by generic type of command. Transaction logs for each system are appended. (Author/LMM)

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ED231401

USERS LOOK AT ONLINE CATALOGS

Part 2: Interacting with Online Catalogs

Final Report to the
Council on Library Resources

by Ray R. Larson

Division of Library Automation
and
Library Studies and Research Division

Office of the Assistant Vice President--
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April 29, 1983

IR050803

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NOTE TO THE READER

This is one of several project reports for this study to be submitted to the Council on Library Resources under separate grant and contract proposals. Reports will also be submitted by:

- J. Matthews and Associates, Inc.
- The Library of Congress
- Online Computer Library Center, Inc.
- The Research Libraries Group, Inc.

The *Data Collection Manual and Sampling Plan* (March 1982), produced by the Research Libraries Group, and the *Data Analysis Plan* (August 1982), produced by the University of California, have been submitted to the Council as separate reports. Addition reports from the University of California include: *Users Look at Online Catalogs: Results of a National Survey of Users and Non-Users of Online Public Access Catalogs*. and *University of California Users Look at MELVYL*.

All reports will be available through the ERIC information service.

A machine-readable file containing all data from the user and non-user questionnaires, suitable for analysis under SPSS, SAS, or other statistical analysis software packages, will be available from the University of California at nominal cost. Full documentation will be provided. For further information, please contact the Project Manager.

ACKNOWLEDGEMENTS

We would like first to acknowledge the financial support of the Council on Library Resources, and the advice, support, and guidance offered by C. Lee Jones, CLR's program officer for this project.

Ray R. Larson, the principal author of this report and designer of the transaction logging system for the University of California's online union catalog, deserves the lion's share of the credit for this paper and the hours of programming and analysis that went into it. Ray was supported in this enterprise by Vicki Graham, Heather Presley, and Joyce Travlos. Professor Michael Cooper of the School of Library and Information Studies, University of California, Berkeley, provided advice and encouragement.

Finally, we want to thank the key people in the organizations who provided transaction log data and documentation for this analysis: Brian Nielsen and Kenton Andersen at Northwestern University, Robert Zich and Pam Bacher at Library of Congress, and Joe Matthews of J. Matthews and Associates, Inc., who arranged to obtain the data from the West Valley Community College District.

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SUMMARY

As one of the five organizations conducting a coordinated study of users and non-users of online catalogs, funded by the Council on Library Resources, the University of California has a dual role. First, it is a participant in the study contributing its share of data and analysis; and second, it is the data processing "utility" for the user and non-user questionnaire data collected by all the participating organizations. It is in the latter role that we submit to the Council this *Final Report* on an analysis of computer transaction logs contributed by four of the online catalog systems participating in the Public Access Project.

The objectives of the national survey were:

1. To produce data and interpretations that will enable designers of public online catalogs to improve system interface features, including command language, displays, search methods, and other matters related to catalog hardware and software.

2. To produce data and interpretations that will enable libraries to improve the implementation and support services (the organization interface) for public online catalogs.

3. To collect additional data that will enable libraries to remove barriers to use of the online catalog and to extend service to potential users.

This report supplements the analyses of User and Non-User Questionnaires by providing analysis of data from the systems themselves.

The four systems contributing data to this analysis were:

- *MUMS/SCORPIO*, two related systems used at the Library of Congress for public access to library holdings, technical processing support, and access to non-bibliographic files.

- *LUIS*, the Northwestern University public access system, which was developed from, and shares equipment, software, and data with, systems for technical processing support and circulation control.

- *ULISYS* (Universal Library Systems), a "turnkey vendor" system that supports circulation control and other library functions, as well as pub-

lic access to the online catalog; the application studied here is the installation at the West Valley Community College District (Mission and West Valley Colleges) in California.

- *MELVYL*, the prototype online union catalog of the University of California. MELVYL runs on mainframe computers located at the University's Systemwide Administration, serves all nine UC campuses, and is designed solely to provide public access to the cataloged holdings of the UC libraries.

The contents of the four transaction logs are described in detail, and samples are provided. Analysis includes, for each system, the relative use of system commands and access points, tables of transitions from one command to another, and measures of the complexity of actual searches conducted by users. Use of commands is analyzed both in "raw" form and by generic "type of command."

Although it proved difficult to make valid generalizations from the log data from these four systems, we found that:

1. *Most users search by subject.* Transaction logs confirm the findings of the CLR questionnaire study: when subject searching capabilities are available, they are used with greater frequency than author and title searching.

2. *Search sequences follow command structures.* A review of command transitions shows that most users follow logical search progressions dictated by the command structures of the computer catalogs, e.g., they begin a session, conduct a search, display results, conduct another search, etc.

3. *Most users conduct simple searches.* Where systems provide complex and sophisticated searching features, they are rarely used.

4. *About ten percent of user commands are errors.* In command-driven systems, over 10 percent of user entries appear to be errors. In MELVYL Lookup Mode, the only menu-driven interface included here, error rates are lower than 2 percent. In command-language systems, the number of errors seem large enough to justify further study and analysis. Error rates can be reduced through system improvement, as shown by a comparison of two different versions of Northwestern's LUIS.

Certainly the most striking aspect of the comparison among systems presented here is the enormous variety represented in these systems: variety in command structures, features, and command languages, as well as variety in the kinds of transaction data recorded by the systems. Merely interpreting the

data from a single log requires a good deal of special information. It is evident that the amount that can be learned from comparing systems is extremely limited. The problems of making valid generalizations from this analysis arise from:

1. Absence of agreement on what variables to include in a transaction log for an online catalog.

2. Absence of standards for defining and measuring those variables.

3. Lack of a conceptual structure that permits comparison of diverse command structures and design approaches.

There is reason to believe that analysis of transaction logs can have both short- and long-range benefits, but we doubt that sufficient knowledge is presently available to immediately solve the problems of theory and standards discussed above. Additional analytical work with transaction logs should be encouraged, but it should be concentrated in individual systems and involve staff with an intimate knowledge of the systems to be analyzed. Work of this sort would have both immediate benefits for the participating systems, and long-run benefits in creating the foundations for standardization and theoretical development that are necessary in order to make valid generalizations from transaction log data.

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Chapter 1

BACKGROUND

1.1 THE CLR PUBLIC ACCESS PROJECT

In early 1981 the Council on Library Resources funded five organizations to conduct a coordinated study of user and non-user responses to public online catalogs. The principals in the project consortium were:

- J. Matthews and Associates, Inc.
- The Library of Congress
- The Online Computer Library Center, Inc. (OCLC)
- The Research Libraries Group (RLG)
- The University of California

The five investigations are independent in the sense that each principal plans to contribute unique methodologies, data, and analyses to the project, and each will report separately. The investigations are coordinated in the sense that they are all built around a jointly-developed survey of users and non-users in all the participating libraries. User and non-user questionnaires were developed, tested and revised by the consortium as a whole, and standard methods of administering and analyzing the questionnaires were adopted by all the participants. The history and organization of the Public Online Catalog Study sponsored by the Council on Library Resources are described in detail in a recent article written by the principal investigators in the project, to which readers of this report are referred.[1]

The University of California has a dual role in this project. As a joint participant, the University will analyze and report on questionnaire data from the UC libraries, and contribute additional data and analyses from the transaction monitoring system of the UC online union catalog, MELVYL. The University

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[1] Douglas Ferguson, *et al.*, "The CLR Public Online Catalog Study: An Overview," *Information Technology and Libraries*, June 1982, pages 84-97.

has also served as the "data processing utility" for the user and non-user survey, providing data conversion, computing, and statistical analysis services for questionnaires contributed by all participants in the project.

This report flows from the second role, which includes the responsibility to report on user and non-user questionnaire results that apply to all twenty-nine libraries participating in the study, and to report on findings from the computer transaction logs provided by some participants.

1.1.1 Goals of the Online Public Access Catalog Study

The user and non-user questionnaires developed by the project consortium focused on identifying the problems that users of online catalogs experience, and their preferences for improving the catalog. Non-users were asked to identify the barriers to their use of the online catalog. The specific goals of the questionnaire study were:

1. To produce data and interpretations that will enable designers of public online catalogs to improve system interface features, including command language, displays, search methods, and other matters related to catalog hardware and software.

2. To produce data and interpretations that will enable libraries to improve the implementation and support services (the organization interface) for public online catalogs.

3. To collect additional data that will enable libraries to remove barriers to use of the online catalog and extend service to potential users.

1.1.2 Data Sources

The sources of data used in this report include machine readable transaction records of user activity from four online catalogs, and additional materials, such as system descriptions, user documentation, and other information provided by participants.

1.1.3 Participants

Twenty-nine library systems participated in the nationwide study of the online catalog. Table 1 lists all participating libraries, grouped by principal investigator. Four of these online catalog systems provided transaction monitor data for processing by DLA. These are indicated by an asterisk following the system name in Table 1. Several other systems in the OCLC group provided transaction data to that institution for analysis; these will be described in the report by OCLC.

1.2 TRANSACTION LOGS AS A DATA SOURCE

Transaction logs of user interaction with online catalogs provide a unique opportunity to observe directly how library users interact with the catalog, a process that until now could not be observed without intruding upon and interrupting the user's search for information and thereby influencing the very process the researcher was attempting to study. This report unearths only a fraction of the wealth of information on catalog use and information seeking behavior that is contained in transaction logs. The report concentrates on command use, and in particular on search commands. In order to provide comparable coverage to the four systems studied, many possible approaches to each individual transaction log file were not pursued. Much of the potential information in transaction logs is of interest only to the system designers, for enhancing or modifying the system. Other information (when available) may be of interest to library management for determining terminal allocations, or for general information on system use.

As Penniman and Dominick point out in their extensive survey of monitoring and evaluation of information systems, transaction log data can provide: "1) Direct and immediate diagnostic aid to the user, 2) group or individual user evaluation, (e.g., analysis of user performance, user success/satisfaction), 3) System protection, (e.g., diagnosis of attempts at unauthorized access) and, 4) System evaluation."[2]

Penniman and Dominick also describe four potential objectives in monitoring information systems:

1. Comparative analysis of two or more versions of the information system to identify the relative improvements made in one version over a previous version.

---

[2] W.D. Penniman and W.D. Dominick, "Monitoring and Evaluation of On-Line Information System Usage," *Information Processing and Management*, 16:17-35 (1980).

TABLE 1

Participating Libraries

Library/Locations	*Library Type*	*System Name*
	University of California (DLA) Group	
Nine campuses	ARL	MELVYL *
	J. Matthews & Associates, Inc. Group	
Claremont Colleges	Acad.	Claremont OLC
Evanston Public Library	Public	CLSI
Mankato State University	Acad.	Mankato OLC
Mission College	Comm. Coll.	ULISYS *
Pikes Peak Library District	Public	Pikes Peak OLC
Steven F. Austin State Univ.	Acad.	DataPhase
West Valley Coll.	Comm. Coll.	ULISYS *
	RLG Group	
Dartmouth College	ARL	Dart. OLC
Northwestern Univ.	ARL	NOTIS/LUIS *
Stanford University	ARL	RLIN II
Library of Congress	State/Fed.	MUMS/SCORPIO *
	OCLC, Inc. Group	
Ohio State University	ARL	LCS
Syracuse University	ARL	SULIRS
Dallas Public Library	Public	LSCAN
Iowa City Public Library	Public	CLSI
State Lib. of Ohio	State/Fed.	OCLC
Univ. of Akron	Acad.	OCLC
Univ. of Texas, Dallas	Acad.	OCLC
Ohio Univ., Athens	Acad.	OCLC
Univ. of Texas, Austin	ARL	OCLC

*--Denotes systems contributing transaction logs to UC/DLA for analysis

2. Comparative analysis of two or more structurings of a database to identify the relative improvements made in one structuring over a previous structuring.

3. Analyses to determine the efficiency for interactions between the information system and its supported data bases or between the information system and its supportive operating system and computer hardware.

4. Analyses to depict usage of the information of any specific database maintained by the information system. This involves identifying profiles of user behavior and analyzing user interaction patterns with the information system and with specific databases.

5. Analyses to determine user success and satisfaction with the information system. (1, p. 23)

This analysis of online catalog transaction monitor data concentrates on the fourth objective, analysis of usage.

In its most basic form, transaction monitoring of an online information system consists of recording in machine readable form all of the information typed at a terminal by a user. However, simple transcription of user input is the most difficult to interpret. Much more information may be gained from a logging system that incorporates a variety of system-generated information in the transaction records, such as, the time and date that the command was entered, a code describing the information system response, indication of the processing time required to complete the command response, etc.

1.3 THE REPORT

This report is limited to a discussion of findings from analyses of computer transaction logs. Chapter One is introductory. Chapter Two discusses computer transaction logs as a source for studying online catalogs. Chapter Three describes the data contained in transaction logs of the four online catalog systems. Chapter Four presents analyses of the transaction data. Chapter Five presents some recommendations for future transaction monitor designers.

Chapter 2

TRANSACTION LOGS: A COMPARISON OF FOUR SYSTEMS

Each of the systems that generated the transaction logs used in this study has different user interfaces, different query languages, different file structures and access points, and different databases. Thus, there can be no direct comparison of transaction data across systems. This chapter briefly describes systems contributing the log records, and the contents of their transaction logs.

2.1 CONTRIBUTING ONLINE CATALOG SYSTEMS

2.1.1 Library of Congress

The Library of Congress utilizes two computer catalog systems: SCORPIO, Subject-Content-Oriented Retriever for Processing Information; and MUMS, Multiple Use MARC System. MUMS originated as a facility for technical processing of records, and SCORPIO began as a retrieval system which furnished legislative data. Online public access to all records was made available to readers through SCORPIO in 1977, and through MUMS in 1978. Author, title, subject, corporate name, personal name, and other access points are available in both systems. Component word searching is also available in MUMS.

2.1.2 Northwestern University

Northwestern University is a private institution whose population is composed of about 6,800 undergraduates, 3,200 graduate students, 2,900 faculty, and 4,500 staff.

The Northwestern computer catalog is known as LUIS (Library User Information Service), and is based on a technical processing and circulation system that uses an IBM 4331. LUIS has been available to library users since mid-1980. During the catalog study, 14 of the 18 available terminals were designated as data collection sites (12 at Main and 2 at the Science and Engineering Library). At the time of the study, Northwestern's database contained about 525,000 records. Book records dated from 1970 and the 70,000

serial records represented nearly 100 percent of the collective holdings of the University's libraries.

LUIS is a command system which offers author, title, and subject access points, but no keyword access (i.e., words in a search term must be entered in a specific order). Implicit right truncation of all search terms is a design feature of the system. Online assistance is provided.

2.1.3 Mission/West Valley Colleges

The West Valley Community College District's computer system, developed by Universal Library Systems (ULISYS), serves two community colleges (West Valley and Mission College in Santa Clara County, California) and approximately 19,000 students. The ULYSIS catalog uses a Digital Equipment Corporation PDP 11/70. Of the system's 33 terminals, 10 are public access catalog terminals (5 at Mission and 5 at West Valley). The database contains about 79,000 records for the two colleges. Catalog users may search by author, title, author and a title word, subject, and call number; and for reserve material, by course and instructor. Explicit Boolean searching and keyword searching, however, currently are not available on the ULISYS system.

2.1.4 University of California

The University of California Online Catalog, MELVYL, is a union catalog available to library users on all nine UC campuses throughout the state, developed and based at the UC Systemwide Administration, Division of Library Automation (DLA) in Berkeley, California. The MELVYL system (which was operating during the study period as a full-scale prototype) uses Magnuson M80/43 CPU's (one for catalog operation, and two others for development and testing, as well as backup systems for the catalog).

MELVYL supports over 100 terminals (including dial-ups) located in the main and branch libraries of all campuses. The MELVYL prototype database contains 733,413 records of monographs held by UC libraries.

Users may search MELVYL using either "Lookup Mode," which provides the basic search and display capabilities via menu selection and prompting, or "Command Mode," which provides more complete search and display capabilities, including index browsing and Boolean searching. MELVYL provides keyword access to personal and corporate authors, titles, subjects, uniform titles, and series. Users may also search for known items using ISBN, LCCN, OCLC number, RLIN number, or the Union Catalog Record Number.

MELVYL includes an integrated authority control system (for names) which provides automatic cross references to authoritative forms of names (i.e., a search for MARK TWAIN will retrieve books by Samuel Langhorne Clemens).

For more detailed data on the user interfaces and system data on the online catalogs included in this report the reader is referred to the following publications: *Online Public Access Catalogs: The User Interface* by Charles Hildreth,[3] and *Public Access to Online Catalogs* by Joseph R. Matthews.[4]

2.2 *TRANSACTION LOG CONTENTS*

Table 2 summarizes the basic information available in the transaction logs provided by the four participating libraries.

As Table 2 shows, there is considerable variation in the contents of transaction log records. There is even greater variation in the actual formats used to represent certain types of information. For example, the date of a transaction from June 1, 1982 would be represented in the Mission Logs as the string '01-Jun-82', in the Northwestern logs it would be '82152' (i.e., the Julian date), and in the UC logs it would be '820601'; LC logs did not record the date.

The protocol required to analyze each type of transaction log also differs considerably. Mission and LC logs contain a single record for each transaction, while Northwestern and UC logs contain two or more records for each transaction (i.e., one record of the user input and another containing system response information).

---

[3] Dublin, OH: OCLC, 1982.

[4] Weston, CN: Online, Inc., 1982.

TABLE 2

Basic Transaction Log Contents

Log Contents	*LC*	*Mission/ West Valley*	*North- western*	*UC*
Transcription of User Input	Y	Y	Y	Y
Terminal ID	Y	Y	Y	Y
Time of Trans. Start	N	Y	Y	Y
Time of Trans. End	N	Y	Y	Y
Date of Trans.	N	P	Y	Y
Session Number	I	I	I	Y
Search Hits	N	Y	Y	Y
Display Format	I	I	Y	Y
Display Quantity	I	I	Y	Y
Error Codes	N	N	Y	Y
System Responses	N	N	Y	Y

CODES:
Y = Yes, contained in the log.
N = No, not contained in the log.
I = May be inferred or computed from the log contents (i.e., by parsing the command)
P = Partially available from the log. (Dates were added to Mission log records during the data collection period)

2.3 *LIBRARY OF CONGRESS MUMS/SCORPIO LOG CONTENTS*

The logs provided by the Library of Congress contain the least amount of information of the four systems studied. Although the LC Systems Office maintains a network monitoring system that provides them with a variety of system information concerning terminal use, response time, and other measures of system and terminal activity, this information was not available in the transaction log tapes provided by LC.

The LC data provided for analysis consisted of a print format image of a terminal screen with the command as input by the user. In addition, the logs included several pieces of information such as the terminal ID and the relative sequence number of the log record. Since data was collected at LC from only a single terminal for each month of the project, the other information on the tape was of little use in analyis. LC logs do not include the date or time of the transaction, or any indication of system response (i.e., number of hits for searches, syntax errors in commands, etc.). An example of the LC log is shown in Appendix A.

2.3.1 Data Collection

The LC data consists of all transactions from a different terminal for each month, March-June, 1982. During March and June, data was collected from a terminal that was primarily for public use. During April, data was collected from a terminal reserved for staff use, and during May, data was collected from a terminal used by both public and staff.

2.3.2 Processing

LC logs were initially reduced from the print format received on tape to a more manageable record format. A parsing program to analyze the the user input text in the logs was developed using the SPITBOL programming language (chosen for its pattern matching capabilities). The parser essentially dissected and tagged each component of the user commands, adding a variety of information that could be inferred from the command text to an output record suitable for analysis by SAS (the Statistical Analysis System). The results of the statistical analysis are presented in the next chapter.

2.4 MISSION/WEST VALLEY COLLEGES ULISYS LOG CONTENTS

The Mission/West Valley College transaction logs from the ULISYS system provided 5 pieces of information:

1. Terminal ID.
2. Command Input Timestamp (in seconds since midnight).
3. System Output Timestamp (in seconds since midnight).
4. Number of Hits (for the current or most recent search).

5. Transcription of the user command.

During the data collection period, an additional data element, the date of the transaction, was added to the transaction logs. The ULISYS transaction logging system does not record any input command that does not have correct syntax or that causes an error. Appendix B contains sample records from the ULISYS logs.

2.4.1 Data Collection

Transactions from all terminals at Mission and West Valley Colleges were captured during the period from March 12, 1982 to June 4, 1982. This was the same period during which the Online Public Access Catalog User and Non-User questionnaires were being administered at that site.

2.4.2 Processing

ULISYS transaction logs required only simple parsing due to the uniformity of the query language syntax (i.e., each command begins with a one or two letter verb, followed by an equal sign "=" and the search terms for search commands). Since the ULISYS system does not provide keyword access or Boolean operations, the search verb itself specifies which index is to be searched.

2.5 NORTHWESTERN NOTIS/LUIS LOG CONTENTS

The LUIS transaction logs from Northwestern University were by far the easiest logs to process, since all of the information required was already present in the logs in a form that could be analyzed immediately by SAS. Complete documentation on log contents and codes was also provided with the log tape by the Northwestern Library Information Systems staff. The Northwestern logs are "event oriented" rather than "transaction oriented." For example, a user command entering the system is one "event," and the system response to the command is another event (and recorded on another log record). The data elements of the Northwestern logs are:

1. Terminal ID.

2. Date of the event (Julian form YYDDD).

3. Time of the event (using a 24 hour clock including tenths of a second).

4. Transaction ID (identifies the system and version of the system generating the record).

5. Task Number (roughly analogous to a session ID number).

6. Attention ID (an indicator as to whether the event was originated by the user or the system).

7. Screen ID (a code identifying the type of data being displayed).

8. Error Message ID (a code indicating the error message being displayed in the event of an error).

9. Command Code (a code identifying the type of command entered by the user).

10. Number of Hits (The number of index records matching the user's most recent search request).

11. Number of Lines Displayed (the number of non-prompt lines displayed on the current screen).

12. MARC format (a code indicating the type of MARC record displayed in a bibliographic display - i.e. Books, Music, Serials, Maps, etc.).

13. LCUS information (a set of three codes describing the messages output by the LCUS circulation control system).

14. Text of input (a transcription of the data entered by users).

Sample records from LUIS logs will be found in Appendix C.

2.5.1 Data Collection

The Northwestern logs used in this report represent a single day's transactions for two different versions of the LUIS system (February 17, 1982 for LUIS 3.1 and March 4, 1982 for LUIS 3.3, with 28,849 and 65,961 transaction records respectively for the day).

2.6 *UNIVERSITY OF CALIFORNIA MELVYL LOG CONTENTS*

The University of California MELVYL system transaction logs are described in detail in *Evaluating Public Access On-Line Catalogs*, by Ray R. Larson,[5] and will only be summarized here.

MELVYL logs are event oriented (as are Northwestern logs), but in the MELVYL logging system the raw "event" records are processed by a batch program to provide a number of different types of output records for processing by SPSS or SAS. Each record type consolidates one or more raw log records into a transaction record for a particular type of transaction (e.g., searches, displays, browses, help, errors, etc.). Aggregated session level records are also produced which provide summary information on each complete user session. Appendix D shows sample records from the MELVYL transaction log.

2.6.1 *Data Collection.*

The MELVYL logs used in this report represent the transactions of all users who were randomly selected for the Online Questionnaire (regardless of whether the user actually completed the questionnaire) between April 2, 1982 and May 31, 1982. Additional information about the general data collection and further analysis of log data will be found in UC's final report on the questionnaire data.[6]

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[5] Ray R. Larson. *Evaluating Public Access Online Catalogs: Phase I Development and Testing of Data Collection and Analysis Tools. Final Report to the Council on Library Resources.* Berkeley, CA.: University of California, Division of Library Automation, July 1981.

[6] University of California, Division of Library Automation and Library Studies and Research Division, *University of California Users Look at Melvyl: Results of a Survey of Users of the University of California Prototype Online Union Catalog. Final Report to the Council on Library Resources.* Berkeley, CA: University of California Systemwide Administration, March 31, 1983.

Chapter 3

STATISTICS ON SYSTEM USE

3.1 COMMAND USE AND COMMAND TRANSITIONS

This section presents, for each participating system, the frequencies of use of the various commands available, the frequencies of command use classified by command type (search, display, etc.), and cross tabulations showing the probability of a user issuing each type of command given the type of command previously issued (command transitions).

3.1.1 Library of Congress MUMS/SCORPIO Commands

The Library of Congress online catalog consists of two systems, MUMS and SCORPIO. Each system has a different query language and database contents, and is presented separately here.

Table 3 shows the frequency and percentages of use of various commands in the MUMS system. MUMS has several commands to retrieve and automatically display records from the database.

The primary search command in MUMS is "FIND," and permits searching for keywords in any part of a personal or corporate name, title, subject, series, notes, or tracings fields of books, serials, and maps records. FIND commands automatically display "hits" in a brief format including a designation of the field in which the keywords were found, the author, title, and call number of the item. Keywords in FIND commands may be searched as phrases, combined with Boolean operators, and limited to matching in specified fields. The complexity of FIND commands will be discussed in a later section of this report.

Several search key commands are available in MUMS for known item searching. These are similar to the truncated search keys used in the OCLC system. The search key commands are (the designation used in Table 3 is listed in parentheses):

TABLE 3

Frequency of Use of MUMS Commands

Ranked in Order of Frequency of Use

Command	Frequency	Percent
NEXT REC/SCREEN	2,353	51.658
FIND SEARCH	645	14.160
AUTHOR KEY SEARCH	418	9.177
LCCN SEARCH	304	6.674
AU/TI KEY SEARCH	219	4.808
BEGIN SESSION	218	4.786
TITLE KEY SEARCH	196	4.303
COMMAND ERROR	70	1.537
DISPLAY BIBL RECORD	41	0.900
XMIT (PAGING)	35	0.768
BREAK IN LOGS	32	0.703
END SESSION	11	0.241
DISPLAY GUIDE	4	0.088
NRAL SEARCH	4	0.088
ISBN SEARCH	2	0.044
COMBINE SETS	1	0.022
SHOW SET HISTORY	1	0.022
SEQUENTIAL REC DISPLAY	1	0.022

1. PATK (AU/TI KEY SEARCH) - This search key uses the first three letters of the author's last name followed by a comma and the first three letters of the first significant word in the title.

2. PTK (TITLE KEY SEARCH) - This search command uses the title, converted to a 3,1,1,1 format. (The first three letters of the first significant word, and the first letter of the next three words).

3. PPNK (AUTHOR KEY SEARCH) - This search command uses either the full name of the author (in inverted form), or the first 6 letters of the last name followed by a comma and the first letter of the author's first name.

4. PCRD (LCCN SEARCH) - This search command permits direct access to bibliographic records with known LCCNs.

5. PSBN (ISBN SEARCH) - This search command permits direct access to bibliographic records with known ISBNs.

6. NRAL (NRAL SEARCH) - This search command is used with an LCCN to search for additional locations for known items included in the National Register of Additional Locations.

As Table 3 shows, the most frequently used commands in MUMS are the 'NEXT PAGE' commands used to move sequentially through long displays. Actual display commands are issued with a lower frequency since displays in default formats are the automatic result of searches.

Tables 3 and 4 show that many more sessions are explicitly begun than are explicitly ended. This is due to the fact that a user may begin new sessions on MUMS (or SCORPIO) at any time without explicitly ending the old session.

TABLE 4

Frequency of Use of MUMS Commands, Classified by Type

Ranked in Order of Frequency of Use

Command Type	Frequency	Percent
DISPLAY PAGING	2,388	52.426
SEARCH COMMAND	1,788	39.254
SESSION START	218	4.786
INVALID COMMAND	70	1.537
DISPLAY COMMAND	46	1.010
SESSION END	43	0.944
SET MANIPULATION	2	0.044

TABLE 5

Command Transitions in MUMS

NEW COMMAND	*OLD COMMAND* (Number/Percent) Display Cmd.	Session End	Invalid Cmd.	Display Paging	Set Manip.	Search Cmd.	Session Start
Display	20 41.67	0 0.00	0 0.00	5 0.21	1 50.00	20 1.14	0 0.00
Session end	1 2.08	9 5.77	4 12.50	16 0.68	0 0.00	7 0.40	6 2.96
Invalid Command	0 0.00	2 1.28	3 9.38	30 1.27	0 0.00	32 1.82	3 1.48
Display Paging	4 8.33	3 1.92	4 12.50	2069 87.71	0 0.00	298 16.99	10 4.93
Set Manip.	0 0.00	0 0.00	0 0.00	1 0.04	0 0.00	1 0.06	0 0.00
Search Command	21 43.75	4 2.56	7 21.88	215 9.11	1 50.00	1356 77.31	184 90.64
Session Start	2 4.17	138 88.46	14 43.75	23 0.97	0 0.00	40 2.28	0 0.00

In this table, and all Command Transition tables that follow, percentages in each column sum to 100 percent.

The SCORPIO system uses a different command language than MUMS, though both systems are available via the same terminals. SCORPIO maintains a number of different files with very different contents, which are as follows:

1. LCCC (Library of Congress Computerized Catalog), which contains books cataloged by LC in English since 1968 and other languages at later dates. The file can be searched by author, title, and subject. As with all SCORPIO files, these access points are available using the words of the name, title or subject in correct order with implicit right-hand truncation.

2. BIBL (Bibliographic Citation File), which contains records of periodical articles, pamphlets and U.S. Government and U.N. publications. It is limited to the current and previous two years and includes citations only in the areas of public policy and current affairs. Access points are subject terms, names of persons, organizations, court cases, names of statutes, and treaties. Subject indexing in this file uses the Legislative Indexing Vocabulary Terms (LIVT) list of terms, which are accessible to the user as an online thesaurus for expanding and determining cross references in searching.

3. NRCM (National Referral Center Master File), which contains listings of over 12,000 organizations and individuals able to provide information on a variety of topics. Access is via name, or topic using subject headings established in the *NRCM Thesaurus*.

4. CG94-98 (Legislative Information files), which contain information on legislation introduced in the U.S. Congress since 1975, there is a separate file for each Session. Access to the files is through LIVT subject headings, bill number, sponsor and cosponsor, committee of referral, bill status, an abstract and a digest of the bill.

5. GAOE, GAOR, GAOS (General Accounting Office Files), which contain information on federal programs, abstracts of reports to Congress of federal agencies, and fiscal and budget information on federal agencies.

While SCORPIO has a rather large command vocabulary, due to special purpose commands used exclusively in specific files, the basic searching process can be accomplished using only a few commands. The user must explicitly begin the search session using the BGNS (BEGIN SESSION) command, including the name of the file to be searched. The user can then use the BRWS (BROWSE INDEX) command to locate the index entries of items of interest. The SLCT (SELECT TERMS) command may then be used to choose one or more index entries for retrieval, and the retrieved items are stored as "sets". The user may then use the DSPL (DISPLAY SET) to display the contents of specified sets, or the COMB (COMBINE SETS) command may be used to combine sets using Boolean operators. To see the next record or screen of a display the user may use the NEXT (NEXT REC/SCREEN) command, or simply press the ENTER key (XMIT) in most cases. The FIND command in SCORPIO is different from the FIND command in MUMS in that it combines the opera-

tions of BRWS, SLCT, COMB, and DSPL for known entries in the index, but it does not perform a keyword search. As Table 6 shows, these few commands make up the bulk of command usage in SCORPIO, while the specialized commands for displaying full records from each of the files,(DISPLAY BIBL RECORD, DISPLAY CGxx RECORD, DISPLAY LCCC RECORD), modifying sets (KEEP SETS, LIMIT SET, DROP SET MEMBER), access to the LIVT thesaurus (SHOW CROSS REFS, USE CROSS REFS), displaying parts of legislation records in the CG files (DISPLAY BILL DIGEST, DISPLAY BILL SUMMARY, DISPLAY BILL INDEXES) and other commands for a special keyword search in the CGxx files, and a number other display commands for special situations in various files, make up a rather small percentage of command use.

Table 7 presents the data from Table 6, classified by the type of action performed by the commands. For example, FIND commands, SLCT commands, keyword searches, NRCM searches, etc., are all put in the category of SEARCH COMMANDS.

Tables 5 and 8 show the probabilities of using one type of command, given the type of command last used. For example, in the SCORPIO system (Table 8), if the user's last (OLD) command was a search, then the next command is most likely to be a display (with a probability of 38.55 percent); if the last command was a browse, the next command is most likely to be a search (with a probability of 49.53 percent). These tables reveal nothing that might not be expected from the structure of the query languages. Generally, a search session is started, searches or browse/searches are performed until the desired records are retrieved, displayed, and paged through.

TABLE 6

Frequency of Use of SCORPIO Commands

Command	Number	Percent
XMIT (PAGING)	7,466	27.630
DISPLAY SET OF RECORDS	4,667	17.272
BROWSE INDEX	3,504	12.968
NEXT REC/SCREEN	3,214	11.894
SELECT TERMS	1,843	6.821
FIND SEARCH	1,522	5.633
BEGIN SESSION	1,211	4.482
COMMAND ERROR	1,206	4.463
END SESSION	1,091	4.038
SHOW SET HISTORY	195	0.722
DISPLAY GUIDE SCREEN	141	0.522
DISPLAY BIBL RECORD	139	0.514
KEEP SETS	115	0.426
COMBINE SETS	104	0.385
DISPLAY BILL DIGEST	85	0.315
DISPLAY BILL SUMMARY	83	0.307
DISPLAY CGxx RECORDS	72	0.266
BREAK IN LOGS	71	0.263
LIMIT SET	60	0.222
SHOW CROSS REFS	50	0.185
DISPLAY LCCC RECORD	42	0.155
USE CROSS REFS	39	0.144
DISPLAY ABSTACT	22	0.081
KEYWORD SEARCH	20	0.074
SHOW SEARCH HISTORY	18	0.067
RETURN TO GUIDE DISPLAY	16	0.059
DISPLAY BILL INDEX	10	0.037
DROP SET MEMBER	7	0.026
SEQUENTIAL RECORD DISPLAY	7	0.026
HELP REQUEST	1	0.004

TABLE 7

Frequency of Use of SCORPIO Commands, Classified by Type

Ranked in Order of Frequency of Use

Command Type	Frequency	Percent
DISPLAY PAGING	10,680	39.501
DISPLAY COMMAND	5,300	19.603
BROWSE COMMAND	3,504	12.960
SEARCH COMMAND	3,385	12.520
SESSION START	1,211	4.479
INVALID COMMAND	1,206	4.461
SESSION END	1,162	4.298
SET MANIPULATION	439	1.624
THESAURUS USE	89	0.329
RETRIEVED SET LIMITING	60	0.222
HELP REQUEST	1	0.004

TABLE 8

Command Transitions in SCORPIO

NEW CMD	*OLD COMMAND* (Number/Percent)										
	Brws	Disp	Ends	Errs	Help	Limt	Page	Sets	Srch	Strt	Thes
Brws	825	606	2	142	0	6	572	14	435	864	38
	23.55	11.44	0.19	11.36	0.00	10.00	5.34	3.19	12.75	70.47	42.70
Disp	105	2950	1	140	0	39	530	171	1344	13	7
	3.00	55.68	0.10	11.20	0.00	65.00	4.95	38.95	39.38	1.06	7.87
Ends	155	237	66	115	1	1	308	21	143	110	5
	4.42	4.47	6.30	9.20	100.0	1.67	2.88	4.78	4.19	8.97	5.62
Errs	76	211	69	420	0	0	216	8	101	101	4
	2.17	3.98	6.59	33.60	0.00	0.00	2.02	1.82	2.96	8.24	4.49
Help	0	0	0	1	0	0	0	0	0	0	0
	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Limt	0	7	0	2	0	11	6	8	25	1	0
	0.00	0.13	0.00	0.16	0.00	18.33	0.06	1.82	0.73	0.08	0.00
Page	535	951	5	236	0	2	8346	113	427	57	8
	15.27	17.95	0.48	18.88	0.00	3.33	77.93	25.74	12.51	4.65	8.99
Sets	13	97	0	12	0	0	139	83	91	3	1
	0.37	1.83	0.00	0.96	0.00	0.00	1.30	18.91	2.67	0.24	1.12
Srch	1735	222	75	66	0	1	431	21	743	77	14
	49.53	4.19	7.16	5.28	0.00	1.67	4.02	4.78	21.77	6.28	15.73
Strt	10	14	829	112	0	0	159	0	85	0	0
	0.29	0.26	79.18	8.96	0.00	0.00	1.48	0.00	2.49	0.00	0.00
Thes	49	3	0	4	0	0	2	0	19	0	12
	1.40	0.06	0.00	0.32	0.00	0.00	0.02	0.00	0.56	0.00	13.48

3.1.2 Mission College ULISYS Commands

The frequencies of command use in the Mission College ULISYS system are shown in Table 9. The most commonly used command in the ULISYS system is the subject search, while the most frequently used class of commands (Table 10) is the display command. ULISYS combines the online catalog with an automated circulation system, permitting users to see the circulation status of books retrieved in their search. This feature seems to be quite popular, in that it is the third most commonly used command in the system. The Mission ULISYS system also maintains searchable files of course reserve materials that may be searched by instructor, course, or a combination of course and instructor. These commands are used rather infrequently when compared to searching in the regular indexes (subject, title, author, and author/title).

TABLE 9

Frequency of Use of ULISYS Commands

Ranked in Order of Frequency of Use

Command	Frequency	Percent
SUBJECT SEARCH	29,386	30.674
TITLES DISPLAY	20,618	21.522
CIRC. STATUS DISPLAY	18,470	19.280
BIBLIOGRAPHIC RECORD DISPLAY	8,474	8.846
TITLE SEARCH	8,248	8.610
AUTHOR SEARCH	7,228	7.545
NEXT SCREEN	2,071	2.162
COURSE/INST. SEARCH	248	0.259
INSTRUCTOR SEARCH	232	0.242
COURSE SEARCH	230	0.240
AUTHOR/TITLE SEARCH	57	0.059

TABLE 10

Frequency of Use of ULISYS Commands, Classified by Type

Ranked in Order of Frequency of Use

Command Type	Frequency	Percent
DISPLAY COMMANDS	47,562	49.647
SEARCH COMMANDS	44,919	46.888
DISPLAY PAGING	2,071	2.162
ALTERNATE SEARCH	710	0.741

TABLE 11

Command Transitions in ULISYS

	NEW COMMAND			
OLD COMMAND	Search Commands	Display Commands	Display Paging	Alternate Search
Search Commands	26,878 59.84	16,725 35.16	912 44.04	172 24.23
Display Commands	16,375 36.45	30,073 63.23	562 27.14	263 37.04
Display Paging	956 2.13	504 1.06	594 28.68	8 1.13
Alternate Search	201 0.45	240 0.50	3 0.14	261 36.76

3.1.3 Northwestern University LUIS Commands

Table 12 shows the command frequencies for the transaction logs from two versions of the Northwestern University LUIS online catalog. The new version of LUIS (version 3.3) incorporates a number of new features that are used heavily. The most interesting change was the provision of three searchable subject heading indexes, LCSH (Library of Congress Subject Headings), MESH (Medical Subject Headings), and Transportation subject headings. The LCSH search command has become the most frequently used search command in the new version. The new method of selecting records to be displayed in full bibliographic format by typing in line numbers from an index display has replaced explicit display commands as the most frequently used command. Like the ULISYS system, LUIS has an associated circulation system, LCUS. However, since these are separate programs, and circulation information is not directly available from LUIS, the use must leave the LUIS program, enter LCUS to inquire after an item's circulation status, and then return to the LUIS program. Since this report concentrates on online catalogs and not circulation systems, the LCUS logs included with the LUIS logs were not included in this analysis. (Note that the missing values in Table 12 were invalid commands or command errors, which are included in Table 13 as "INVALID COMMANDS". Also, note that only explicit help commands, entered by users and recorded in the logs, are counted in the "HELP" category; the display of introductory screens is not included in this count).

TABLE 12

Frequency of Use of LUIS Commands

Ranked in Order of Frequency of Use in LUIS 3.3

Command	*LUIS 3.3* Frequency	*LUIS 3.3* Percent	*LUIS 3.1* Frequency	*LUIS 3.1* Percent
DISP OF INDEX LINE	4,013	28.601	N/A	
NEXT BIB RECORD	2,611	18.609	967	10.915
LCSH SEARCH	1,453	10.356	N/A	
TITLE SEARCH	1,321	9.415	2,131	24.055
GUIDE REDISPLAY	1,192	8.495	72	0.813
AUTHOR SEARCH	950	6.771	1,324	14.945
END SESSION	778	5.545	234	2.641
INDEX DISPLAY	395	2.815	1,044	11.785
REQ LUIS PROGRAM	327	2.331	N/A	
REQ CIRC INQUIRY	310	2.209	355	4.007
INVALID COMMAND	306	2.181	N/A	
REQ HELP SCREEN	234	1.668	135	1.524
BIBL. DISPLAY	81	0.577	2,597	29.315
TRANSP. SUBJ. SEARCH	35	0.249	N/A	
MESH SEARCH	25	0.178	N/A	
(Missing)	1,468		1,854	

TABLE 13

Frequency of Use of LUIS Commands, Classified by Type

Ranked in Order of Frequency of Use in LUIS 3.3

Command Type	*LUIS 3.3* Frequency	*LUIS 3.3* Percent	*LUIS 3.1* Frequency	*LUIS 3.1* Percent
DISPLAY COMMANDS	5,681	36.654	3,713	34.659
SEARCH COMMANDS	3,784	24.414	3,455	32.251
DISPLAY PAGING	2,611	16.846	967	9.026
INVALID COMMANDS	1,774	11.446	1,854	17.306
SESSION END	778	5.020	234	2.184
SYSTEM TRANSFER	637	4.110	355	3.314
HELP COMMANDS	234	1.510	135	1.260

TABLE 14

Command Transitions in LUIS 3.1

NEW COMMAND	*OLD COMMAND* (Number/Percent) Display Cmds	Session End	Invalid Cmds	Help Cmds	Display Paging	Search Cmds	System Trans.
Display Commands	2135 57.52	2 0.85	97 5.23	10 7.41	134 13.86	1334 38.61	1 0.28
Session End	87 2.34	2 0.85	27 1.46	9 6.67	14 1.45	91 2.63	4 1.13
Invalid Commands	275 7.41	19 8.12	1005 54.21	38 28.15	36 3.72	283 8.19	198 55.77
Help Commands	14 0.38	0 0.00	30 1.62	4 2.96	2 0.21	85 2.46	0 0.00
Display Paging	229 6.17	0 0.00	28 1.51	1 0.74	700 72.39	9 0.26	0 0.00
Search Commands	867 23.36	200 85.47	476 25.67	70 51.85	79 8.17	1611 46.63	151 42.54
System Transfer	105 2.83	11 4.70	191 10.30	3 2.22	2 0.21	42 1.22	1 0.28

TABLE 15

Command Transitions in LUIS 3.3

NEW COMMAND	*OLD COMMAND* (Number/Percent) Display Cmds	Session End	Invalid Cmds	Help Cmds	Display Paging	Search Cmds	System Trans.
Display Commands	3694 65.02	2 0.26	208 11.72	15 6.41	486 18.61	1252 33.09	24 3.77
Session End	244 4.30	2 0.26	103 5.81	36 15.38	86 3.29	303 8.01	4 0.63
Invalid Commands	302 5.32	65 8.37	941 53.04	44 18.80	120 4.60	262 6.92	40 6.28
Help Commands	25 0.44	1 0.13	10 0.56	1 0.43	10 0.38	186 4.92	1 0.16
Display Paging	518 9.12	0 0.00	118 6.65	2 0.85	1765 67.60	203 5.36	5 0.78
Search Commands	711 12.52	679 87.39	365 20.57	134 57.26	134 5.13	1521 40.20	240 37.68
System Transfer	187 3.29	28 3.60	29 1.63	2 0.85	10 0.38	57 1.51	323 50.71

3.1.4 University of California MELVYL Commands

Table 16 shows the frequency of use of MELVYL commands in Command Mode and the equivalent actions resulting from menu selection in Lookup Mode. The primary search command in MELVYL Command Mode is "FIND", followed by an index code and the keywords to be searched. Multiple groups of indexes and keywords may also be combined in a find command using Boolean operators. Once a FIND command has retrieved records, the user may display them in a number of formats, or modify the retrieved set by modifying the search. (This is done by beginning a command with a Boolean operator fol-

lowed by an index code and keywords, or by "AND DATE" followed by a range of dates). The user may also limit the retrieved set to items held by a particular UC library or group of libraries by specifying a location. If unsatisfied with the results of a modifying search, the user may issue a "BACKUP" command to restore the results of the last search. An alternate method of searching is to perform a "BROWSE" of a specified index and then "SELECT" the numbered index entries to be retrieved.

Table 17 shows the commands classified by type.

Table 18 shows the command transitions for a sample of Command Mode sessions. Lookup Mode sessions are not shown as command transitions due to the predominance of menu selection in the command transition logs.

TABLE 16

Frequency of Use of MELVYL Commands

Ranked in Order of Frequency of Use in COMMAND Mode

	Command Mode		*Lookup Mode**	
Command Type	Frequency	Percent	Frequency	Percent
DISPLAY PAGING	8,324	35.855	N/A*	0.000
FIND SEARCHES	4,615	19.879	7,939	29.543
DISPLAY COMMANDS	3,213	13.840	15,668	58.304
INVALID COMMANDS	2,530	10.898	447	1.663
HELP COMMANDS	1,728	7.443	108	0.402
SESSION END	1,575	6.784	2,707	10.073
LOCATION SEARCH	384	1.654	N/A	0.000
BROWSE COMMANDS	360	1.551	N/A	0.000
SELECT SEARCH	175	0.754	N/A	0.000
MODIFYING SEARCH	161	0.693	N/A	0.000
PARAM. SETTING	143	0.616	4	0.015
SEARCH BACKUP	8	0.034	N/A	0.000

* Since Lookup Mode uses menu selection rather than explicit commands entered by the user, these frequencies are based on the Command Mode version of the Lookup menu selection. Display paging is included under display commands, since it also requires explicit menu selection.

TABLE 17

Frequency of Use of MELVYL Commands, Classified by Type

Ranked in Order of Frequency of Use in COMMAND Mode

	Command Mode		*Lookup Mode**	
Command Type	Frequency	Percent	Frequency	Percent
DISPLAY PAGING	8,324	35.855	N/A*	0.000
SEARCH COMMANDS	5,343	23.014	7,939	29.543
DISPLAY COMMANDS	3,213	13.840	15,668	58.304
INVALID COMMANDS	2,530	10.898	447	1.663
HELP COMMANDS	1,728	7.443	108	0.402
SESSION END	1,575	6.784	2,707	10.073
BROWSE COMMANDS	360	1.654	N/A	0.000
PARAM. SETTING	143	0.616	4	0.015

* Since Lookup Mode uses menu selection rather than explicit commands entered by the user, these frequencies are based on the Command Mode version of the Lookup menu selection. Display paging is included under display commands, since it also requires explicit menu selection.

TABLE 18

Command Transitions in MELVYL COMMAND Mode

NEW COMMAND	*OLD COMMAND* (Number/Percent)								
	Brws	Disp	Ends	Errs	Help	Page	Srch	Strt	Parm
Browse	11	8	0	8	3	3	7	0	0
	20.75	2.33	0.00	2.59	1.73	0.24	1.43	0.00	0.00
Display	1	57	0	24	10	42	147	0	0
	1.89	16.57	0.00	7.77	5.78	3.38	30.12	0.00	0.00
Ends	0	19	2	22	13	39	49	0	5
	0.00	5.52	4.44	7.12	7.51	3.06	10.04	0.00	25.00
Errors	9	34	0	111	27	81	58	14	2
	16.98	9.38	0.00	35.92	15.61	6.36	11.89	100.0	10.00
Help	2	6	1	45	58	10	15	0	4
	3.77	1.74	2.22	14.56	33.53	0.79	3.07	0.00	20.00
Page	15	184	41	33	6	1044	1	0	0
	28.30	53.49	91.11	10.68	3.47	82.01	0.20	0.00	0.00
Search	15	35	0	63	47	49	206	0	6
	28.30	10.17	0.00	20.39	27.17	3.85	42.21	0.00	30.00
Set Param.	0	1	1	3	9	4	5	0	3
	0.00	0.29	2.22	0.97	5.20	0.31	1.02	0.00	15.00

NOTE: This table represents a sample of one week's transactions from users sampled for the questionnaire. Lookup Mode "command transitions" are not presented since menu selection predominates all Lookup Mode interactions.

3.2 INDEX USE

In the Online Public Access Catalog questionnaire study, it was found that subjects were the most frequently used access points in online catalog searches. Analysis of transaction logs for the four systems examined here reaffirms this finding. Tables 19 to 23 show the frequencies of use for the various access points available in the four systems studied.

3.2.1 MUMS/SCORPIO Index Use

A particular index does not need to be specified when searching in MUMS or SCORPIO. In MUMS, the user may optionally specify particular fields to be searched for given keywords in "FIND" commands. However, if no access field is specified then the search defaults to a "general index" including all access fields. Access fields used in MUMS are presented in Table 19 The abbreviated search keys included in Table 19 account for a large percentage of searches in MUMS, indicating a large amount of known item searching. All searching in SCORPIO is through BROWSE/SELECT and COMBINE commands (or the SCORPIO version of FIND, which has the same effect). In SCORPIO users select the line numbers from a display of index headings to retrieve items indexed by those headings. Thus the only information available in the transaction log files is a line number, giving no indication of the type of heading being selected. SCORPIO indexes were therefore not available for analysis.

TABLE 19

Frequency of Use of Access Points in MUMS

Index	Frequency	Percent
GENERAL INDEX	503	28.148
AUTHOR KEY	417	23.335
LCCN	308	17.236
AU/TI KEY	219	12.255
TITLE KEY	196	10.968
TITLE	57	3.190
SUBJECT	54	3.022
CORPORATE AUTHOR	11	0.616
PERSONAL AUTHOR	10	0.560
SERIES + CORP. A	4	0.224
PERS AU + TITLE	3	0.168
SUBJECT + TITLE	2	0.112
ISBN	2	0.112
SERIES	1	0.056

3.2.2 ULISYS Index Use

Subject searching in ULISYS is by far the most commonly used access point, accounting for over 65 percent of all searches. Table 20 shows the access points used in searches recorded in the ULISYS logs.

TABLE 20

Frequency of Use of Access Points in ULISYS

Access Point	Frequency	Percent
Subject	29,386	65.420
Title	8,248	18.362
Author	7,228	16.091
Author/Title	57	0.127

3.2.3 LUIS Index Use

Tables 21 and 22 show the access points used in LUIS 3.1 and LUIS 3.3 respectively. The addition of subjects as access points in LUIS 3.3 has made a significant impact on users' searching behavior.

Subject searching in the LCSH index has become the most common form of access to LUIS records, a place formerly held by title searches. The changes in frequency of use of the various access points seems to indicate that subject searching has replaced over one third of the searches formerly carried out in the author and title indexes, with the greatest decrease in the amount of title searching. This would seem to indicate that many users were probably using title searches as a form of subject access rather than for known item searching.

TABLE 21

Frequency of Use of Access Points in LUIS 3.1

Access Point	Frequency	Percent
Title	2,131	61.679
Author	1,324	38.321

TABLE 22

Frequency of Use of Access Points in LUIS 3.3

Access Point	Frequency	Percent
LCSH	1,453	38.399
Title	1,321	34.910
Author	950	25.106
Trans Subj	35	0.925
MESH	25	0.661

3.2.4 MELVYL Index Use

In MELVYL Command Mode, the indexes to be searched must be specified in the search command. In Lookup Mode, however, the user is given the choice of "Author/Title" or "Subject" searching, and the system constructs a Command Mode search statement based on user input.

In Lookup Mode, the system automatically searches both the Personal Author (PA) and Corporate Author (CA) indexes for author keywords. In subject searches, the system causes subject keywords to be searches in both the

Subject (SU) and Title (TI) indexes. If, for example, the user selects an Author/Title search and types in author name "x" and title "y" in response to Lookup prompts, the system constructs a Command Mode search statement "FIND PA x OR CA x AND TI y." If the user enters only a title and nothing in response to the author prompt, the system constructs a "FIND TI y" search. If only an author name is entered, the system constructs the search as "FIND PA x OR CA x." If the user selects a subject search and enters 'z' in response to the prompt for subject terms, the system constructs the search as "FIND SU z OR TI z."

This automatic construction of Boolean search statements was designed with the assumption that Lookup Mode users would usually be beginners at using the system and might not be aware of the distinctions of personal and corporate authorship or the limit vocabulary imposed by Library of Congress subject headings. Lookup Mode was designed to be "forgiving."

As Table 23 shows, in Command Mode the subject index is the most frequently used single index, while the subject option in Lookup Mode (SU & TI) accounts for well over half of Lookup Mode searches.

TABLE 23

Frequency of Use of Access Points in MELVYL

Ranked in Order of Frequency of Use in COMMAND Mode

Indexes Used	*Command Mode* Frequency	Percent	*Lookup Mode* Frequency	Percent
SU	2,286	46.710	N/A	0.000
PA	1,159	23.682	N/A	0.000
TI	990	20.229	613	7.721
DATE OR LOCATION	449	[1]	N/A	0.000
TI & PA	192	3.923	N/A	0.000
CA	106	2.166	N/A	0.000
SE	49	1.001	N/A	0.000
SU & TI	34	0.695	4,840	60.965
SU & PA	26	0.531	N/A	0.000
TI & CA	21	0.429	27	0.340
UT	19	0.388	N/A	0.000
SU & CA	5	0.102	N/A	0.000
PA & CA	3	0.061	1,266	15.947
SE & PA	2	0.041	N/A	0.000
SU & PA & TI	1	0.020	N/A	0.000
SE & SU	1	0.020	N/A	0.000
TI & PA & CA	N/U	0.000	1,163	14.649

KEY: PA = Personal Author
CA = Corporate Author
TI = Title
SU = Subject
UT = Uniform Title
SE = Series

NOTE: [1]Date and Location processing were not included in the percentages, since they are not used for direct retrieval, but only to modify retrieved sets of records.

3.3 QUERY COMPLEXITY

This section examines the complexity of search statements entered by users in the four systems studied. Complexity here refers to the use of system features such as Boolean operators, phrase searching, truncation of keywords, and retrieval set limiting functions.

3.4 QUERY COMPLEXITY IN ULYSIS AND LUIS

Two of the systems studied, ULISYS and LUIS, permit little in the way of query complexity since neither system uses keyword access or Boolean operators. For these systems, only the number of keywords used in search statements can be considered as a complexity measure. Table 24 shows the number of words used in ULISYS search statements. Table 25 breaks down the number of words in the search statement by the index searched for ULISYS searches. Tables 26 and 27 provide the same information for searches in LUIS 3.1. Tables 28 and 29 show the breakdown for LUIS 3.3 searches.

TABLE 24

Number of Words Used in Search Statements in ULISYS

Number of Words	Frequency	Percent
1	22,099	49.197
2	12,397	32.051
3	4,602	10.245
4	2,230	4.964
5	949	2.113
6	368	0.819
7	172	0.383
8	55	0.122
9	18	0.040
10	14	0.031
11	8	0.018
12	3	0.007
13	1	0.002
16	2	0.004
21	1	0.002

TABLE 25

Words Used in Search Statement by Type of Search, ULISYS

Number Of Words	*Author/Title* N	%	*Author* N	%	*Subject* N	%	*Title* N	%
1	55	96.49	2,713	37.53	17,356	59.06	1,975	23.95
2	1	1.75	3,500	48.42	8,702	26.61	2,194	26.60
3	1	1.75	670	9.27	2,158	7.34	1,773	21.50
4	0	0.00	285	3.94	730	2.48	1,215	14.73
5	0	0.00	35	0.48	277	0.94	637	7.72
6	0	0.00	12	0.17	98	0.33	258	3.13
7	0	0.00	4	0.06	45	0.15	123	1.49
8	0	0.00	7	0.10	9	0.03	39	0.47
9	0	0.00	0	0.00	7	0.02	11	0.13
10	0	0.00	1	0.01	0	0.00	13	0.16
11	0	0.00	0	0.00	2	0.01	6	0.07
12	0	0.00	0	0.00	0	0.00	3	0.04
13	0	0.00	0	0.00	0	0.00	1	0.01
16	0	0.00	0	0.00	2	0.01	0	0.00
21	0	0.00	1	0.01	0	0.00	0	0.00

TABLE 26

Number of Words Used in Search Statements in LUIS 3.1

Number of Words	Frequency	Percent
1	94	2.721
2	1,254	36.295
3	1,046	30.275
4	505	14.616
5	288	8.336
6	136	3.936
7	86	2.489
8	30	.868
9	12	.347
10	2	.058
11	1	.029
12	1	.029

TABLE 27

Words Used in Search Statement by Type of Search, LUIS 3.1

	Author		*Title*	
Number of Words	Frequency	Percent	Frequency	Percent
1	43	3.25	51	2.39
2	660	49.85	594	27.87
3	498	37.61	548	25.72
4	103	7.78	402	18.86
5	10	0.76	278	13.05
6	6	0.45	130	6.10
7	1	0.08	85	3.99
8	1	0.08	29	1.36
9	1	0.08	11	0.52
10	1	0.08	1	0.05
11	0	0.00	1	0.05
12	0	0.00	1	0.05

TABLE 28

Number of Words Used in Search Statements in LUIS 3.3

Number of Words	Frequency	Percent
1	355	9.382
2	1,450	38.319
3	1,142	30.180
4	443	11.707
5	217	5.735
6	100	2.643
7	58	1.533
8	15	0.396
9	4	0.106

TABLE 29

Words Used in Search Statement by Type of Search, LUIS 3.3

Number	*Author*		*LCSH*		*MESH*		*Trans Sub*		*Title*	
Of Words	N	%	N	%	N	%	N	%	N	%
1	65	6.84	203	13.97	4	16.00	6	17.14	77	5.83
2	475	50.00	657	45.22	15	60.00	17	48.57	286	21.65
3	303	31.89	446	30.70	6	24.00	11	31.43	376	28.46
4	88	9.26	106	7.30	0	0.00	1	2.86	248	18.77
5	12	1.26	26	1.79	0	0.00	0	0.00	179	13.55
6	5	0.53	7	0.48	0	0.00	0	0.00	88	6.66
7	1	0.11	7	0.48	0	0.00	0	0.00	50	3.79
8	1	0.11	1	0.07	0	0.00	0	0.00	13	0.98
9	0	0.11	0	0.00	0	0.00	0	0.00	4	0.30

3.4.1 *MUMS/SCORPIO Query Complexity*

The MUMS and SCORPIO command languages permit the user a rather bewildering number of options in searching. In MUMS, the user may combine keywords, field specifications, and phrases (groups of words enclosed in quotes which must be matched in the order specified and adjacent to each other in a record for retrieval to take place). Retrieval may also be limited to a specific MUMS file (BOOKS, SERIALS, or MAPS) using a "file qualifier" in the search statement.

However, these advanced searching features are used rather sparingly by users. Of the 1787 MUMS searches in the logs, only 645 (36.094 percent) are "FIND" searches. Of these, only 142 (22.016 percent of all FIND searches) use a specified access field and only 9 (1.395 percent) used two access fields. None of the recorded searches used more than two specified access fields in a single search. There were 110 FIND searches (17.054 percent) that used at least one Boolean operator, and of these, only 17 (2.636 percent) used more than one. The maximum number of Boolean operators used in a FIND search was 4. The phrase searching feature of MUMS is also used infrequently, with only 26 of the FIND searches (4.031 percent) incorporating a phrase. Twenty-one of the FIND searches (3.256 percent) used a file qualifier.

Abbreviated key searches in MUMS permit the user to limit the retrieved set by using an imprint date or title word qualifier appended to the search key. Of the 1142 searches in MUMS using abbreviated search keys, a surprising 471 searches (41.243 percent) used an imprint date (442 or 38.704 percent) or title word (29 or 2.539 percent) as a qualifier.

SCORPIO searches can be quite complex, primarily due to the "set" orientation of the query language, with its set manipulation and set limiting commands. However, these commands are used relatively little by users (as may be seen in Tables 3 and 4). Most users seem to be satisfied by simple browse/select searches without using the more advanced set manipulation features of SCORPIO.

TABLE 30

Number of Words Used in MUMS "FIND" Searches

Number of Words	Frequency	Percent
1	52	8.387
2	266	42.903
3	174	28.065
4	68	10.968
5	26	4.194
6	14	2.258
7	12	1.935
8	5	0.806
9	3	0.484

TABLE 31

Number of Words Used in SCORPIO "FIND" Searches

Number of Words	Frequency	Percent
1	963	63.272
2	290	19.054
3	131	8.607
4	77	5.059
5	36	2.365
6	9	0.591
7	4	0.263
8	5	0.329
12	4	0.263
13	3	0.197

TABLE 32

Number of Words in SCORPIO Browse Commands

Number of Words	Frequency	Percent
1	1311	37.414
2	1242	35.445
3	547	15.611
4	212	6.050
5	125	3.567
6	45	1.284
7	16	0.457
8	5	0.143
9	1	0.029

3.4.2 MELVYL Query Complexity

MELVYL Command Mode allows the user to construct very complex searches, since MELVYL is keyword oriented and permits Boolean operations both within a specified index and between specified indexes. For example, "FIND TI x AND NOT y" would retrieve all books with titles containing the keyword "x" excluding those that also had the keyword "y" in the title. "FIND TI x OR y AND SU z" would retrieve all books with either of the keywords "x" or "y" in the title that also had keyword "z" in a subject heading. Keywords may also be truncated using the pound sign "#". Thus, "FIND TI LIBRAR#" would retrieve all titles containing the words LIBRARY, LIBRARIES, LIBRARIANS, etc.

Since Lookup Mode constructs search statements automatically from keywords entered by the user in response to prompts, the complexity of Lookup searches is not a matter of concern for the user. That is, in Lookup Mode the user need not be concerned with Boolean operators or other system features, since all such matters are handled by the system. The following discussion is limited therefore to Command Mode "FIND" searches, where the user must consciously formulate a search statement.

There were 4,615 Command Mode "FIND" searches in the transaction logs studied. Of these, 4,259 (92.286 percent) used only a single index, 249

(5.395 percent) used 2 indexes, 4 (0.152 percent) used three indexes, and 1 (0.022 percent) each used 4 and 5 indexes. (Note that Table 23 shows the indexes specified in search commands regardless of the number of times the index is repeated within a search statement. Therefore, a search statement such as "FIND SU x OR SU y" would appear in Table 23 under "SU" since that is the only index used in the search).

Keyword truncation was used in 154 searches (3.337 percent). Boolean operations between keywords with the same index were used more commonly. In the first index/keyword group of "FIND" searches, 1263 (27.367 percent) used a single keyword, while 3352 (72.633 percent) used explicit Boolean operations between keywords, with 7 (0.209 percent) combining Boolean operations and truncation.

In general, the complexity of queries in online catalogs is quite low, with the advanced features of the systems for Boolean operations, truncation of keywords, etc., used relatively infrequently when compared with the most simple searches. However, it is obvious that some users do use the Boolean capabilities of online catalogs when a simple search retrieves too much or too little material.

TABLE 33

Number of Words in MELVYL Lookup Mode Searches

Number of Words	Frequency	Percent
1	122	1.537
2	2180	27.459
3	210	2.645
4	2443	30.772
5	204	2.570
6	1206	15.191
7	218	2.746
8	583	7.343
9	135	1.700
10	278	3.502
11	52	0.655
12	128	1.612
13	24	0.302
14	64	0.806
15	16	0.202
16	35	0.441
17	4	0.050
18	20	0.252
19	2	0.025
20	14	0.176
21	1	0.013

TABLE 34

Number of Words in MELVYL Command Mode Searches

Number of Words	Frequency	Percent
1	1200	24.321
2	1826	37.009
3	876	17.754
4	478	9.688
5	270	5.472
6	128	2.594
7	75	1.520
8	32	0.649
9	23	0.466
10	15	0.304
11	8	0.162
12	1	0.020
13	1	0.020
15	1	0.020

Chapter 4

SUMMARY AND CONCLUDING OBSERVATIONS

4.1 SUMMARY OF FINDINGS

1. *Most users search by subject.* Transaction logs confirm the findings of the CLR questionnaire study: when subject searching capabilities are available, they are used with greater frequency than author and title searching. The most dramatic support for this finding comes from LUIS, where the addition of subject access in Version 3.3 significantly reduced the relative proportion of searches by author, and cut the proportion of title searches almost in half.

2. *Search sequences follow command structures.* A review of command transitions shows that most users follow logical search progressions dictated by the command structures of the computer catalogs, e.g., they begin a session, conduct a search, display results, conduct another search, etc.

3. *Most users conduct simple searches.* Where systems provide complex and sophisticated searching features, they are rarely used. In the Library of Congress SCORPIO system, for example, most users conduct simple "browse/select" searches, generally ignoring the powerful set storage and manipulation features of the system.

4. *About ten percent of user commands are errors.* In LUIS 3.3 and MELVYL Command Mode, over 10 percent of user entries (11.45 and 10.9 percent, respectively) are recorded as errors; in LUIS 3.1, this proportion was over 17 percent. Error rates appear lower in the Library of Congress systems (between 2 and 5 percent). In MELVYL Lookup Mode, the only menu-driven interface included here, error rates are lower than 2 percent. Whatever the relative virtues of menu and command systems, it is evident (and hardly surprising) that the use of menus reduces the incidence of (and opportunity for) user errors. In command-language systems, the number of errors seem large enough to justify further study and analysis. Error rates can be reduced through system improvement: as noted previously, the rate dropped from 17 percent to 11 percent when LUIS 3.3 was introduced.

4.2 CONCLUDING OBSERVATIONS

Certainly the most striking aspect of the comparison among systems presented here is the enormous variety represented in these systems: variety in command structures, features, and command languages, as well as variety in the kinds of transaction data recorded by the systems. Merely interpreting the data from a single log requires a good deal of special information. For example, the most common "error" in MELVYL Command Mode is an erroneous paging command, generated when the user presses "Return" when there are no more records to display. This "error" is by no means serious, either from the user's point of view or that of the system, yet it is given equal status in the logs with more serious errors that may affect search results and user satisfaction to a significant degree.

Given the burden of "special interpretation" needed to analyze even one system's records, it is evident that the amount that can be learned from comparing systems is extremely limited. The limitations initially arise from the absence of standard definitions for transaction log variables (or even earlier, with the absence of standards for variables to include), and are compounded at a higher level by the lack of an accepted conceptual structure that would permit comparing results from systems with different approaches, features and design philosophies.

It is not our intention here to advocate the development of appropriate theories and standards, although we believe that such developments are necessary and desirable. We question, though, whether enough is known in detail about the use of current online catalog systems and the issues arising from their use to guide higher-level development and standardization.

There is good reason to believe that the detailed analysis of transaction logs from online catalogs can yield both important information for immediate application and well-grounded findings and questions that can help to inform and guide the high-level developments discussed above. Additional work in this area should be encouraged, but at the present "state of the art" we believe the work should be done in individual systems, and by analysts, librarians and system designers who are intimately familiar with the specific systems under investigation. The results of such inquiries promise both immediate benefits for the systems themselves and a firm foundation for higher-level activities that could eventually produce valid generalizations about user interaction with online catalogs.

Appendix A

LIBRARY OF CONGRESS TRANSACTION LOGS

```
TR CODE ZSGN    TIOA LEN  3.064    AID CHAR 00  TERM TYPE 12 CURSOR ADDR 0000   COMPAT TERM TYPE 00 COMPAT TERM MOD 00 TERM MODEL FO
COMPAT REAL TERM TYPE 00   COMPAT REAL TERM MOD 00   SMI POSITION 00   COMPAT MODE FLAG 00   COMPAT SCREEN SIZE 00 DATA LEN     31

0006                1        10        20        30        40        50        60        70        80        90        100
                    *ZSGN aid=serials,sec=ossi,oper1
```

```
TR CODE ZNLD   TIOA LEN  3,064   AID CHAR 00  TERM TYPE 12 CURSOR ADDR 0000   COMPAT TERM TYPE 00 COMPAT TERM MOD 00 TERM MODEL FO
COMPAT REAL TERM TYPE 00   COMPAT REAL TERM MOD 00   SMI POSITION 00   COMPAT MODE FLAG 00   COMPAT SCREEN SIZE 00 DATA LEN      4

0007          1       10        20        30        40        50        60        70        80        90        100
```

```
TR CODE PPNK   TIOA LEN  3,064   AID CHAR 00  TERM TYPE 12 CURSOR ADDR 0000  COMPAT TERM TYPE 00 COMPAT TERM MOD 00 TERM MODEL FO
COMPAT REAL TERM TYPE 00   COMPAT REAL TERM MOD 00   SMI POSITION 00   COMPAT MODE FLAG 00   COMPAT SCREEN SIZE 00 DATA LEN     10

0008                1        10        20        30        40        50        60        70        80        90        100
                    *PPNK uh!.w
```

```
TR CODE PPNK   TIOA LEN  3,064   AID CHAR 00  TERM TYPE 12 CURSOR ADDR 0000   COMPAT TERM TYPE 00 COMPAT TERM MOD 00 TERM MODEL FO
COMPAT REAL TERM TYPE 00   COMPAT REAL TERM MOD 00   SMI POSITION 00   COMPAT MODE FLAG 00   COMPAT SCREEN SIZE 00 DATA LEN     11

0009          1        10        20        30        40        50        60        70        80        90        100
              .PPNK jewett
```

```
TR CODE PTK     TIOA LEN  3,064   AID CHAR 00  TERM TYPE 12 CURSOR ADDR 0000   COMPAT TERM TYPE 00 COMPAT TERM MOD 00 TERM MODEL FO
COMPAT REAL TERM TYPE 00   COMPAT REAL TERM MOD 00   SMI POSITION 00   COMPAT MODE FLAG 00   COMPAT SCREEN SIZE 00 DATA LEN     10

0010          1        10        20        30        40        50        60        70        80        90        100
              .........................................................................................
              *PTK thejoa
              *                                                                                       *
              *                                                                                       *
              *                                                                                       *
```

```
TR CODE PTK     TIOA LEN  3,064   AID CHAR 00  TERM TYPE 12 CURSOR ADDR 0000   COMPAT TERM TYPE 00 COMPAT TERM MOD 00 TERM MODEL FO
COMPAT REAL TERM TYPE 00   COMPAT REAL TERM MOD 00   SMI POSITION 00   COMPAT MODE FLAG 00   COMPAT SCREEN SIZE 00 DATA LEN      7

0011          1       10        20        30        40        50        60        70        80        90       100
              .PTK pla
```

76

77

```
TR CODE PTK     TIOA LEN  3,064   AID CHAR 00  TERM TYPE 12 CURSOR ADDR 0000   COMPAT TERM TYPE 00 COMPAT TERM MOD 00 TERM MODEL FO
COMPAT REAL TERM TYPE 00   COMPAT REAL TERM MOD 00   SMI POSITION 00   COMPAT MODE FLAG 00   COMPAT SCREEN SIZE 00 DATA LEN      8

0012                  1       10        20        30        40        50        60        70        80        90        100
                      *PTK stos
```

```
TR CODE PTK     TIOA LEN  3,064   AID CHAR 00  TERM TYPE 12 CURSOR ADDR 0000   COMPAT TERM TYPE 00 COMPAT TERM MOD 00 TERM MODEL FO
COMPAT REAL TERM TYPE 00   COMPAT REAL TERM MOD 00   SMI POSITION 00   COMPAT MODE FLAG 00   COMPAT SCREEN SIZE 00 DATA LEN      10

0013                 1       10        20        30        40        50        60        70        80        90        100
                     .....................................................................................................
                     .PTK sboppf                                                                                         .
                     .                                                                                                   .
                     .                                                                                                   .
                     .                                                                                                   
```

```
TR CODE PTK    TIOA LEN 3,064   AID CHAR 00  TERM TYPE 12 CURSOR ADDR 0000   COMPAT TERM TYPE 00 COMPAT TERM MOD 00 TERM MODEL FO
COMPAT REAL TERM TYPE 00   COMPAT REAL TERM MOD 00   SMI POSITION 00   COMPAT MODE FLAG 00   COMPAT SCREEN SIZE 00 DATA LEN      10

0014              1       10        20        30        40        50        60        70        80        90        100
                  *PTK 197s21
                  *                                                                                                 *
                  *                                                                                                 *
                  *                                                                                                 *
```

```
TR CODE PTK    TIOA LEN  3,064   AID CHAR 00  TERM TYPE 12 CURSOR ADDR 0000   COMPAT TERM TYPE 00 COMPAT TERM MOD 00 TERM MODEL FO
COMPAT REAL TERM TYPE 00   COMPAT REAL TERM MOD 00   SMI POSITION 00   COMPAT MODE FLAG 00   COMPAT SCREEN SIZE 00 DATA LEN      8

0015          1       10        20        30        40        50        60        70        80        90       100
```

```
TR CODE PAGE   TIOA LEN  3,064   AID CHAR 00  TERM TYPE 12 CURSOR ADDR 0000   COMPAT TERM TYPE 00 COMPAT TERM MOD 00 TERM MODEL FO
COMPAT REAL TERM TYPE 00   COMPAT REAL TERM MOD 00   SMI POSITION 00   COMPAT MODE FLAG 00   COMPAT SCREEN SIZE 00 DATA LEN     12

0016          1       10        20        30        40        50        60        70        80        90        100
              .....................................................................................................
              .PAGE govf                                                                                            .
              .s9                                                                                                   .
              .                                                                                                     .
              .                                                                                                     .
              .                                                                                                     
```

```
TR CODE PTK     TIDA LEN  3,064   AID CHAR 00  TERM TYPE 12 CURSOR ADDR 0000   COMPAT TERM TYPE 00 COMPAT TERM MOD 00 TERM MODEL FO
COMPAT REAL TERM TYPE 00   COMPAT REAL TERM MOD 00   SMI POSITION 00   COMPAT MODE FLAG 00   COMPAT SCREEN SIZE 00 DATA LEN      10

0017                1        10        20        30        40        50        60        70        80        90        100
                    *PTK offnca
```

```
TR CODE PAGE   TIOA LEN  3,064   AID CHAR 00  TERM TYPE 12 CURSOR ADDR 0000   COMPAT TERM TYPE 00 COMPAT TERM MOD 00 TERM MODEL F0
COMPAT REAL TERM TYPE 00   COMPAT REAL TERM MOD 00   SMI POSITION 00   COMPAT MODE FLAG 00   COMPAT SCREEN SIZE 00 DATA LEN     14

0018                1       10        20        30        40        50        60        70        80        90        100
                    .........................................................................................
                    .PAGE offnca                                                                            .
                    .s5                                                                                     .
                    .                                                                                       .
                    .                                                                                       .
                    .                                                                                       
```

```
TR CODE PTK     TIOA LEN  3,064   AID CHAR 00  TERM TYPE 12 CURSOR ADDR 0000   COMPAT TERM TYPE 00 COMPAT TERM MOD 00 TERM MODEL FO
COMPAT REAL TERM TYPE 00   COMPAT REAL TERM MOD 00   SMI POSITION 00   COMPAT MODE FLAG 00   COMPAT SCREEN SIZE 00 DATA LEN      7

 0019                1        10        20        30        40        50        60        70        80        90       100
                     +---------+---------+---------+---------+---------+---------+---------+---------+---------+---------+
                     |PTK sea                                                                                             |
                     |                                                                                                    |
                     |                                                                                                    |
                     |                                                                                                    
```

Appendix B

MISSION VALLEY ULISYS TRANSACTION LOGS

```
21358813588300S=MARKETING
21359633596315DT=3
21360423604400S=MARKETING
21360713607215DT=3
21361753617601ST=1
21361913619225281=1
21355863558725 5S=NEW TRENDS
21355993560100T=NEW TRENDS
21356373563902ST=2
21356773567925 2T=CHANGES
21357163571804T=EDUCATIONAL CHANGE
21357323573300S=EDUCATIONAL CHANGE
21357713577200S=ADVANCES IN ED
21358003580300T=THE YEAR 2000
21358153584400T=FUTURE
21358993590050ST=2
21359153591625 2ST=1
21359353593825 2ST=5
21360373603925 2S=FUTURE OF EDUCATION
21360623606800S=EDUCATION
21361313613250S=EDUCATION--ADDRESSES, ESSAUS. ;
21361613616600S=EDUCATION
21362013620350S=EDUCATION--ADDRESSES, ESSAYS, LECTURES
21362203622107ST=5
21362563625725 2BI=5
21363083630925 5BI=1
21363333633725 5S=EDUCATION
21363653636650S=EDUCATION--AIMS AND OBJECTIVES--ADDRESSES, ESSAYS, LECTURES
21363823638201S=1
21364173642201S=EDUCATION
21364453644750S=EDUCATION--AIMS AND OBJECTIVES--ADDRESSES
21364543645501ST=1
21432954329825 2S=MARIJUANA
21433274332801ST=1
21433504336425 2S=DRUGS
21434644346444DT=38
21434814349600S=DRUGS
21435084351044DT=38
21435524355301DT=38
21435724359001ST=1
21436534367525 2S=POT
21437154379048S=MARIJUANA
21438144381801BI=1
21438494385025 5ST=1
21446354463625 2S=DRAFT
21446944471702S=MILITARY
21447944479547DT=17
21448074480901DT=18
21448184482001DT=32
21448514486201BI=1
21448764488125 5DT=38
21448934489704DT=39
21449094491204DT=42
21449224492301DT=43
21449494496601S=MILITARY
21449794498047DT=43
21450124501701DT=44
21450904509106DT=45
21451124511401DT=46
```

```
214514145148O1DT=47
21451794518101ST=1
21691166911700CO=BIOLOGY
216914169141028I=1
216917369173255S=CHEMORECEPTOR CELLS
216920869209005=TASTEBUDS
477104171061255A=WILLIAMS
47710417113750NS
477118471186501N=WILLIAMS
4771216712160ICO=**262
477126371264001N=WILLIAMS
477129671298011N=WILLIAMS
47713077152901AUTHOR=WILLIAMS
47713397136450AUTHOR=WILLIAMS
22651546515600S=BUSINESS LAW
226523065230045T=1
226525565255252BI=2
307309173093252T=ODD COUPLE
30730987310100A=SIMON N
307329473296120N=RA790.6.M39
30733027330201ST=1
```

Appendix C

NORTHWESTERN UNIVERSITY LUIS TRANSACTION LOGS

```
L3PS820480845438L#ISO0315'     A                a=bennett addis
L3PS820480845451L#ISO0315 I   BA  000405
L3PS820480845535L#ISO0315'I   BB  000405       1
L3PS820480845552L#ISO0315 B    B  000411B
L3PS820480846592L#ISO0315'B    B  000411B       2
L3PS820480847008L#ISO0315 B   CB  000410B
L3PS820480847228L#ISO0315'B   CB  000410B       1
L3PS820480847253L#ISO0315 B    B  000411B
L3PS820480847331L#ISO0315'B    B  000411B       2
L3PS820480847348L#ISO0315 B   CB  000410B
L3PS820480847383L#ISO0315'B   CB  000410B       3
L3PS820480847399L#ISO0315 B    B  000409B
L3PS820480847457L#ISO0315'B    B  000409B       4
L3PS820480847473L#ISO0315 B   CB  000408B
L3PS820480847517L#ISO0315'B   CB  000408B       2
L3PS820480847534L#ISO0315 B   CB  000410B
L3PS820480853046L#ISO0315'B   CE  000410B       e
L3PS820480853066L#ISO0315      E  000019
L3PS820480905419L#ISO0942'     A                a=gouhier,henri
L3PS820480905438L#ISO0942 I   BA  001112
L3PS820480905524L#ISO0942'I   BD  001112       d
L3PS820480905524L#ISO0942 XC          19
L3PS820480905524L#ISO0942'                     D
L3PS820480936246L#ISO1830'     A                a=kelsey
L3PS820480936255L#ISO1830 G   IA  003310
L3PS820480936360L#ISO1830'G   II  003310       1
L3PS820480936392L#ISO1830 I   BI  003318
L3PS820480937133L#ISO1830'I   BM  003318       m
L3PS820480937161L#ISO1830 I   BM  003317
L3PS820480937567L#ISO1830'I   BB  003317       26
L3PS820480937581L#ISO1830 B    B  003308B
L3PS820480938111L#ISO1830'B       003308B
L3PS820480938111L#ISO1830 B T     003308
L3PS820480938121L#ISO1830_B T     003308
L3PS820480938143L#ISO1830         000019
L3PS820481019422L#ISO3174   J     000019
L3PS820481019422L#ISO3174'                     tfederal  probation
L3PS820481020120L#ISO3191'     T               t=federal probation
L3PS820481020142L#ISO3191 B    T  000110S
L3PS820481022280L#ISO3191'B    T  000110S       t=hospital and community psychiatry
L3PS820481022289L#ISO3191 I   BT  000203
L3PS820481026357L#ISO3191'I   BT  000203       t=family coordinator
L3PS820481026367L#ISO3191 I   BT  000203
L3PS820481027479L#ISO3191'I   BB  000203       2
L3PS820481027495L#ISO3191 B    B  000207S
L3PS820481029043L#ISO3191'B    T  000207S       t=family  process
L3PS820481029052L#ISO3191 I   BT  000304
L3PS820481029341L#ISO3191'I   BB  000304       1
L3PS820481029363L#ISO3191 B    B  000314S
L3PS820481030348L#ISO3191'B    T  000314S       t=federal probation
L3PS820481030369L#ISO3191 B    T  000110S
L3PS820481032004L#ISO3191'B    T  000110S       t=health and social work
L3PS820481032008L#ISO3191 E   NT  000001
L3PS820481032146L#ISO3191'E    N  000001
L3PS820481032146L#ISO3191 E  TN   000001
L3PS820481032378L#ISO3191'E  TNT  000001       t=health and social work
L3PS820481032384L#ISO3191 E   NT  000001
L3PS820481032497L#ISO3191 E  TN   000001
L3PS820481032497L#ISO3191'E   N   000001
```

```
L3PS820481032599L#ISO3191 E TN   000001
L3PS820481032599L#ISO3191'E TN   000001
L3PS820481033011L#ISO3191 E TN   000001
L3PS820481033011L#ISO3191'E TN   000001
L3PS820481033024L#ISO3191'E TN   000001
L3PS820481033024L#ISO3191 E TN   000001
L3PS820481033226L#ISO3191'E TNT  000001    t=health and social work
L3PS820481033232L#ISO3191 E  NT  000001
L3PS820481033372L#ISO3191'E  N   000001
L3PS820481033372L#ISO3191 E TN   000001
L3PS820481034366L#ISO3191'E TNT  000001    t=georgia journal of corrections
L3PS820481034391L#ISO3191 E  NT  000001
L3PS820481034482L#ISO3191'E  N   000001
L3PS820481034482L#ISO3191 E TN   000001
L3PS820481035215L#ISO3191'E TNT  000001    t=family therapy
L3PS820481035224L#ISO3191 G  IT  002007
L3PS820481035456L#ISO3191'G  II  002007    1
L3PS820481035489L#ISO3191 I  BI  002018
L3PS820481036347L#ISO3191 I TB   002018
L3PS820481036347L#ISO3191'I  B   002018
L3PS820481036398L#ISO3191'I TB   002018
L3PS820481036398L#ISO3191 I TB   002018
L3PS820481036444L#ISO3191'I TBB  002018    1
L3PS820481036460L#ISO3191 B  B   002008B
L3PS820481036593L#ISO3191'B  B   002008B   1
L3PS820481037007L#ISO3191 B  B   002008B
L3PS820481037224L#ISO3191'B  T   002008B   t=family therapy
L3PS820481037232L#ISO3191 G  IT  002007
L3PS820481038500L#ISO3191'G  II  002007    1
L3PS820481038529L#ISO3191 I  BI  002018
L3PS820481039312L#ISO3191'I  BM  002018    m
L3PS820481039322L#ISO3191 I  BM  002004
L3PS820481838488L#IS18761'    T            t=free to choose
L3PS820481838498L#IS18761 I  BT  000304
L3PS820481839479L#IS18761 I TB   000304
L3PS820481839479L#IS18761'I  B   000304
L3PS820481840002L#IS18761'I TBE  000304    e=
L3PS820481840022L#IS18761     E  000019
L3PT820481300146L#IS08322'    T            t=pension plans under erisa
L3PT820481300163L#IS08322 B   T  000108B
L3PT820481300313L#IS08322'B   A  000108B   a=goldberg,s.
L3PT820481300337L#IS08322 I  BA  001516
L3PT820481301554L#IS08322'I  B   001516    luis
L3PT820481301554L#IS08322 I JB   001516
L3PT820481302172L#IS08322'I JBT  001516    t=luis
L3PT820481302181L#IS08322 G  IT  004214
L3PT820481302216L#IS08322 G JI   004214
L3PT820481302216L#IS08322'G  I   004214    luius
L3PT820481302252L#IS08322'G JI   004214    luis
L3PT820481302252L#IS08322 G JI   004214
L3PT820481302321L#IS08322 XC         19
L3PT820481302321L#IS08322'                 D=luis
L3PT820481302321L#IS08322'G JID  004214    d=luis
L3PU820480945434L#IS02122    J   000019
L3PU820480945434L#IS02122'                 s=el savador
L3PU820481347137L#IS10269'    T            t=comparative literature
L3PU820481347162L#IS10269 I  BT  001516
L3PU820481347203L#IS10269'I  B   001516
L3PU820481347203L#IS10269 I TB   001516
L3PU820481347436L#IS10269'I TBB  001516    b=1
L3PU820481347457L#IS10269 B  CB  001509S
L3PU820481348172L#IS10269'B  CI  001509S   i=
```

```
L3PU820481348195L#IS10269 I  BI  001516
L3PU820481348265L#IS10269'I  BB  001516      b=12
L3PU820481348302L#IS10269 B  CB  001510S
L3PU820481348537L#IS10269_B  C   001510S
L3PU820481348557L#IS10269        000019
L3PU820482101459L#IS20294'    D              d=320.97306;H758p
L3PU820482101459L#IS20294'                   D=320.97306;H758p
L3PU820482101459L#IS20294 XC         19
L3PV820481210044L#IS06665'E TET  000001      t=ncaa basketball rules
L3PV820481210049L#IS06665 E  NT  000001
L3PV820481210261L#IS06665'E  N   000001
L3PV820481210261L#IS06665 E TN   000001
L3PV820481210501L#IS06665'E TN   000001      n=rules of national collegiate athletic associatio
L3PV820481210501L#IS06665 E JN   000001
L3PV820481210589L#IS06665 E TN   000001
L3PV820481210589L#IS06665'E JN   000001
L3PV820481211188L#IS06665'E TNT  000001      t=rules for national collegiate athletic ass
L3PV820481211193L#IS06665 E  NT  000001
L3PV820481214061L#IS06665_E  N   000001
L3PV820481214082L#IS06665        000019
L3PV820481555512L#IS15304'    T              t=pensions & investments age
L3PV820481555518L#IS15304 E  NT  000001
L3PV820481556075L#IS15304 E TN   000001
L3PV820481556075L#IS15304'E  N   000001
L3PV820481556118L#IS15304'E TN   000001
L3PV820481556118L#IS15304 E TN   000001
L3PV820481556169L#IS15304'E TN?  000001      ?
L3PV820481556242L#IS15304 E GE?  000001
L3PV820481557139L#IS15304 E JEG  000001
L3PV820481557139L#IS15304'E GEG  000001      g=pensions & investment age
L3PV820481557298L#IS15304'E JEE  000001      e=
L3PV820481557319L#IS15304     E  000019
L3PV820481907211L#IS18975'    A              a=bouch
L3PV820481907222L#IS18975 G  IA  010416
L3PV820481907332L#IS18975'G  II  010416      15
L3PV820481907361L#IS18975 I  BI  010418
L3PV820481907555L#IS18975'I  BB  010418      40
L3PV820481907575L#IS18975 B  CB  010412B
L3PV820481908109L#IS18975'B  CI  010412B     i=40
L3PV820481908139L#IS18975 I  BI  010418
L3PV820481908300L#IS18975'I  BI  010418      i==65
L3PV820481908330L#IS18975 I  BI  010418
L3PV820481908450L#IS18975'I  BI  010418      i=81
L3PV820481908486L#IS18975 I  BI  010418
L3PV820481909153L#IS18975'I  BI  010418      i=97
L3PV820481909170L#IS18975 I  BI  010409
L3PV820481909338L#IS18975_I  B   010409
L3PV820481909359L#IS18975        000019
L3PW820481556570L#IS15334'    I              i=eli lilly
L3PW820481556570L#IS15334   J I  000019
```

Appendix D

UNIVERSITY OF CALIFORNIA MELVYL TRANSACTION LOGS

University of California MELVYL Transaction Log Records

Note that certain binary fields in MELVYL log records will appear here as non-printing or special characters.

```
11012083032614491 1  .Ó  .[00509D002324        CLK0010000  FIND    SU AIR-CRAFT ENGINEERING OR TI AIR-CRAFT ENGINEERING
11012083032614491 1  ì   .[00509D002324        ISE10000000000F   0000  FIND SU AIR-CRAFT ENGINEERING OR TI AIR-CRAFT ENGINEERING
11012083032614501 4  ▌   ▌ 00509D002324        C00010013
11012083032614501 4  É   Ç 00509D002324        C0004
11012083032614501 4  ]_  ]%00206F002326        C00010013
11012083032614501 4  ³_  ³¬00206F002326        C000100515,17
11012083032614501 4  ³Q  ³¬00206F002326        CLK0020000  DISPLAY 15,17 LONG
11012083032614501 4  6Ì  2h00206F002326        EDI0000100000150101   ]1
11012083032614501 4   B   B00206F002326        C00010011
11012083032614501 4   F   B00206F002326        LK0020000  NS
11012083032614501 4  ä   à 00206F002326        EDI0000200000170201   ]1
11012083032614511 8  :   : 00206F002326        C00010013
11012083032614511 8      00206F002326        C00010051
11012083032614511 8      00206F002326        CLK0020000  DISPLAY 1  LONG
11012083032614511 8  ñ   00206F002326        EDI0000100000010101   ]1
11012083032614522 1  |Ü  |Ü00206F002326        C00010012
11012083032614522 1  ßÿ  ß/00206F002326        C000100217
11012083032614522 1  ßò  ß/00206F002326        CLK0020000  DISPLAY 17 LONG
11012083032614522 1  @?  ÁQ00206F002326        EDI0000100000170101  ] 1
11012083032614522 1  W   W 00206F002326        C00010014
11012083032614522 1      ¬00206F002326        C0001008GEOMETRY
11012083032614522 1  õ   ¬00206F002326        CLK0010000  FIND    SU GEOMETRY OR TI GEOMETRY
11012083032614532 4  ▯   ¬00206F002326        ISE00100000000    0000
11012083032614532 4  ▯   ¬00206F002326        ISE100131906401   0000  FIND SU GEOMETRY OR TI GEOMETRY
11012083032614532 4  -   ; 00206F002326        EDI0000100000140113    3
11012083032614532 4  C_  C%00206F002326        C00010011
11012083032614491 1  âÎ  â!011072002330        ISE10000000000    0000  FIND SU TEACHUB2 OR TI TEACHUB2
11012083032614501 4  ¡)  ¦*011072002330        C00010012
11012083032614501 4  Ñ   Ñ 011072002330        C0001035TEACHING READING IN THE FIRST GRADE
11012083032614501 4  Ñ   Ñ 011072002330        CLK0010000 îFIND    SU TEACHING READING IN THE FIRST GRADE OR TI TEACHING READING IN
11012083032614501 4  ÍÄ  Ñ 011072002330        ISE10000000000    0000 êFIND SU TEACHING READING IN THE FIRST GRADE OR TI TEACHING RE
11012083032614501 4  Z   Y011072002330        C0001012LILLIAN GRAY
11012083032614501 4  µ   Y011072002330        CLK0030002
11012083032614501 4  á     011072002330        C00010011
11012083032614511 8       005085002378        C0001029BROWSE SU PARATHYROID SURGERY
11012083032614511 8  Ù    005085002378        EDI0000100000010101  ] 4
11012083032614511 8  "   =005085002378        C0001008SELECT 1
11012083032614511 8  Í   =005085002378        C0500           (      Á
11012083032614511 8  Ó   =005085002378        ISE30000020002    0000  BROWSE SU PARATHYROID SURGERY (SELECT 1)
11012083032614511 8  }   =005085002378        ISE10000020002    0000  BROWSE SU PARATHYROID SURGERY (SELECT 1)
11012083032614522 1  ã   ã 005085002378        C0001006D LONG
11012083032614522 1  ç¬  ]E005085002378        EDI0000100000010101   ]1
11012083032614522 1  qÙ  qÚ005085002378        C0001031BROWSE PA CORNELIUS E. SEDGWICH
11012083032614522 1  NG  NF005085002378        C0001031BROWSE PA CORNELIUS E. SEDGWICK
11012083032614522 1  Üò  Ú+005085002378        EDI0000100000020102  ] 4
11012083032614522 1      =005085002378        C0001010SELECT 1 2
11012083032614532 4  m   =005085002378        ISE30000010001    0000  BROWSE PA CORNELIUS E. SEDGWICK (SELECT 1 2)
11012083032614532 4  o   =005085002378        ISE10000010001    0000  BROWSE PA CORNELIUS E. SEDGWICK (SELECT 1 2)
11012083032614532 4  M    005085002378        EDI0000100000010101  ] 0
11012083032614532 4  |   |005085002378        C0001000
11012083032614532 4  î   |005085002378        DHE004060
11012083032614718 1  ó   ó004073002392        C0001061F TI AMERICAN SOCIETY OF PLUMBING ENGINEERS BOOK OF STANDARDS
11012083032614718 1  ëú  ó004073002392        ISE10000000000    0000  F TI AMERICAN SOCIETY OF PLUMBING ENGINEERS BOOK OF STANDARDS
11012083032614824 1  âP  âP004073002392        C0001061F SU AMERICAN SOCIETY OF PLUMBING ENGINEERS BOOK OF STANDARDS
11012083032614824 1  +2  âP004073002392        ISE10000000000    0000  F SU AMERICAN SOCIETY OF PLUMBING ENGINEERS BOOK OF STANDARDS
11012083032614930 1  A   A004073002392        C0001061F CA AMERICAN SOCIETY OF PLUMBING ENGINEERS BOOK OF STANDARDS
```

```
110120830326152930 Ñ    A004073002392
110120830326152930  çf   çe004073002392
110120830326152930  ê§   ê0004073002392
110120830326152615  õX   õW006052002393
110120830326155455   H    G015089002434
110120830326155455   Ø    G015089002434
110120830326155558  `I   `H015089002434
110120830326155558  `P   `H015089002434
110120830328113413 ;~   ;9 026041003084
110120830328113516 ;~   ;9 026041003084
110120830328113516 ¬èu  ¬èu026041003084
110120830328113516 ¬ï   ¬èu026041003084
110120830328113516 ¬a°  ¬a 026041003084
```

```
ISE10000000000    0000  F CA AMERICAN SOCIETY OF PLUMBING ENGINEERS BOOK OF STANDARDS
 C0001003END
 C0004
 C0003M02T03SD
 C0001019FIND LOPEZ AND 1966
DHE004086  FIND LOPEZ AND 1966
 C0001022FIND PA LOPEZ AND 1966
DHE004096FIND PA LOPEZ AND 1966
ISE10000000000    0000  FIND SU GEODESICS
 C0500            u     <
 C0001017FIND SE GEODESICS
ISE10000000000    0000  FIND SE GEODESICS
 C0001003END
```